

ET Door Drive Actuator Anomalies & Repair Plan

**Jeff Goodmark
Boeing Mechanical Systems SSM**

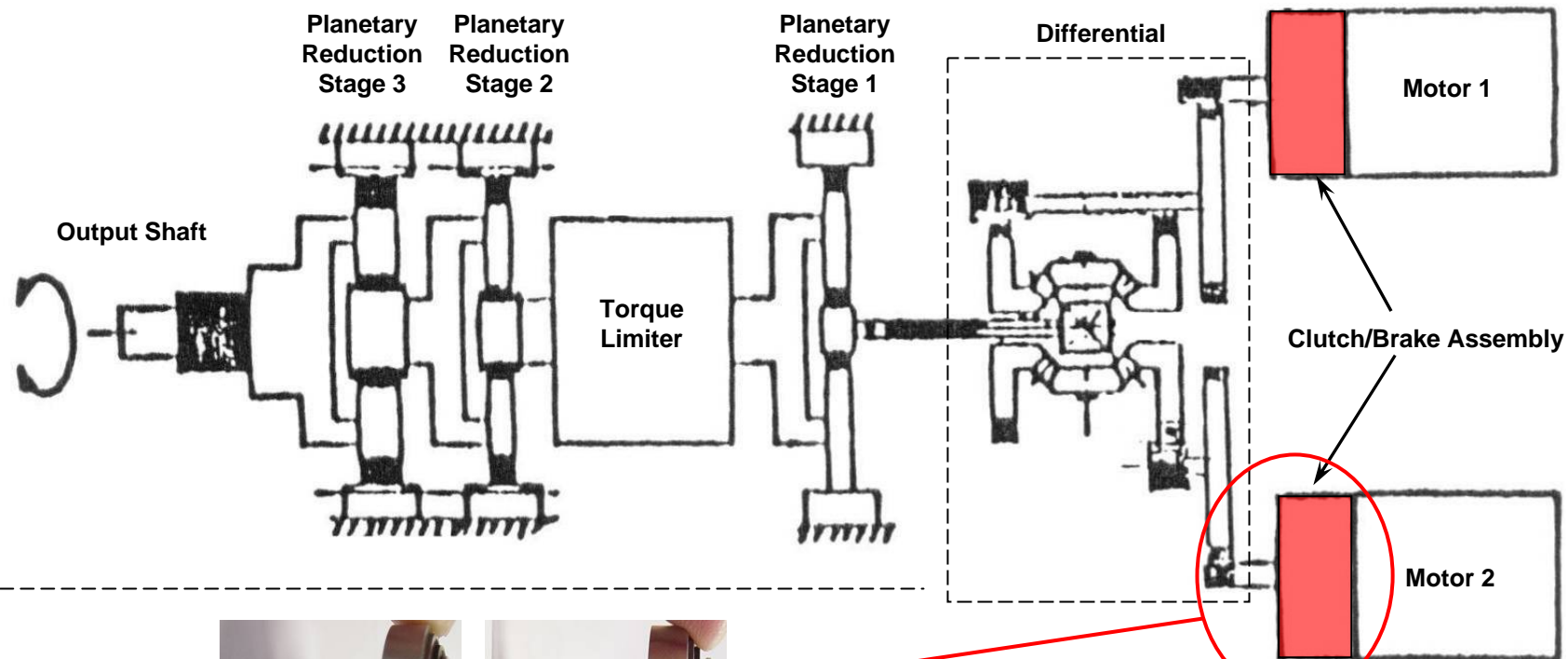
**OPO Technical Tagup
06/18/08**

Issue



- ET Door drive actuators currently have three discrepant conditions:
 - 1) Torque limiter degradation
 - 2) Motor clutch/brake wear
 - 3) Undersized torque limiter pusher & ramp balls
- Items 1 and 2 contribute to reduced actuator stall torque
 - Flight rationale supported by successful 1-g door functional test
 - Actuators continue to trend steadily downward
- PRT recommends to remedy all three discrepancies on attrition basis
 - R&R as next spare becomes available and flow schedule allows

ET Door Drive Actuator



Brake mode:
Disk spring-loaded
against stator, locks
input to differential.
Motor output is
disengaged.



Clutch mode:
Disk magnetically
pulled away from
brake stator,
allowing rotation.
Motor output is
engaged.

Background



- Torque limiter degradation
 - Discovered in 2002
 - Caused by Braycote grease contamination on friction disks during assembly
 - Time-related (slow migration of oil onto disk surfaces)
 - On-vehicle trending implemented every flow with ET Door push test
 - Remedied by disassembly & thorough cleaning of torque limiter components
- Motor clutch/brake disk wear
 - Discovered in 2006 during push testing for item 1
 - Results in premature slippage of clutch and/or brake disks
 - Root cause unknown
 - Cycle-related, but observed trend is not linear
 - Remedied by replacing clutch/brake assemblies with new spares
- Undersized torque limiter pusher & ramp balls
 - Discovered in 2002 during failure analysis for item 1
 - Caused by mislabeled packaging at ball supplier
 - Present in qual unit and all flight units
 - Accepted as-is due to nominal actuator performance
 - MRD required for each repaired actuator prior to shipment from Telair
 - Recent Engineering evaluation testing shows that torque limiter adjustment requires fewer iterations with correct balls (process improvement)

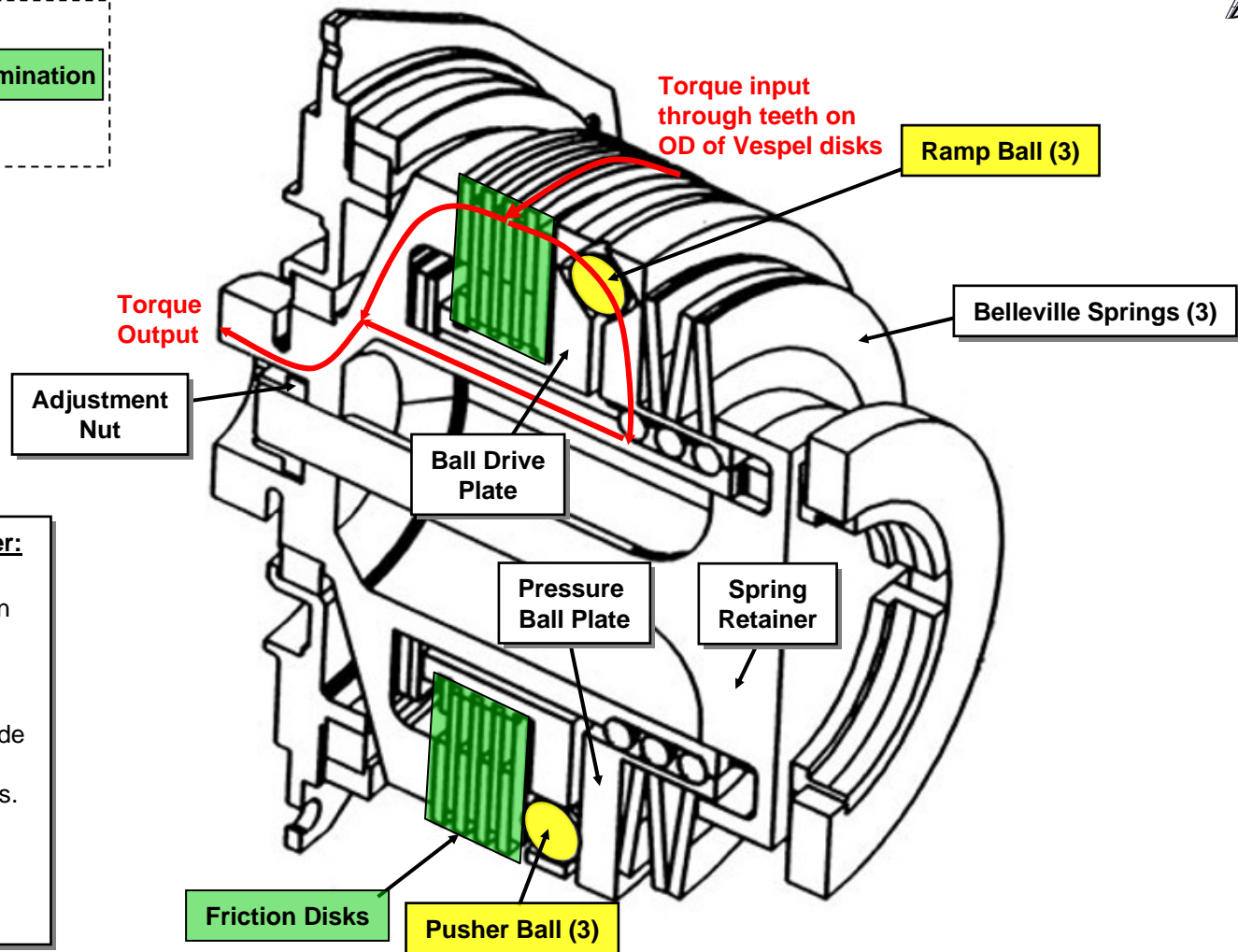
Torque Limiter Diagram



Discrepancies:

Braycote Grease Contamination

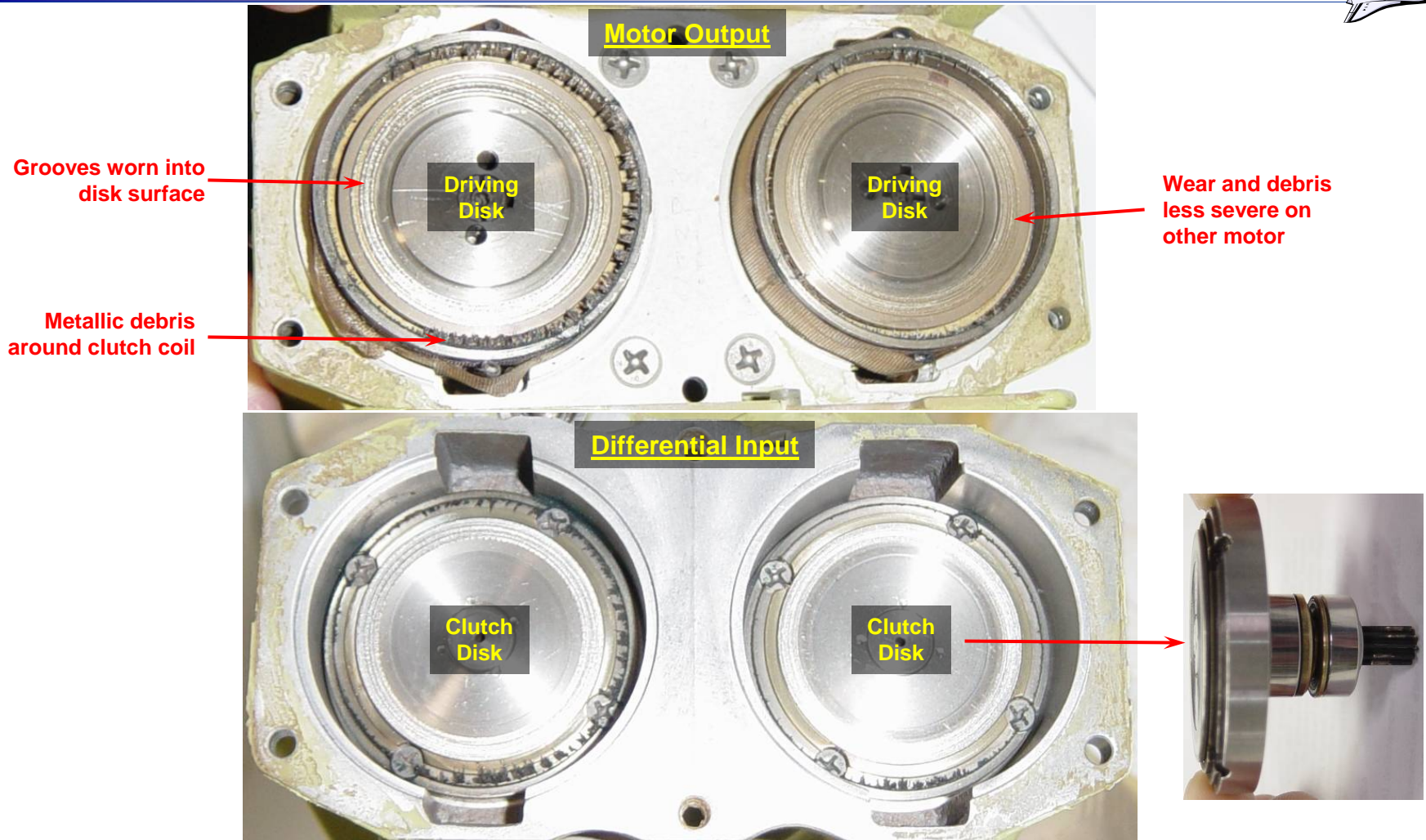
Undersized



Ball Ramp Torque Limiter:

- Drive torque forces ramp balls into narrower portion of cones, trying to force plates apart.
- Belleville springs hold plates together and provide friction disk compression force through pusher balls.
- At slip torque, ramp ball overcomes spring force and separates plates, allowing disks to slip.

Example of Clutch Disk Wear (TU114)



Current Status

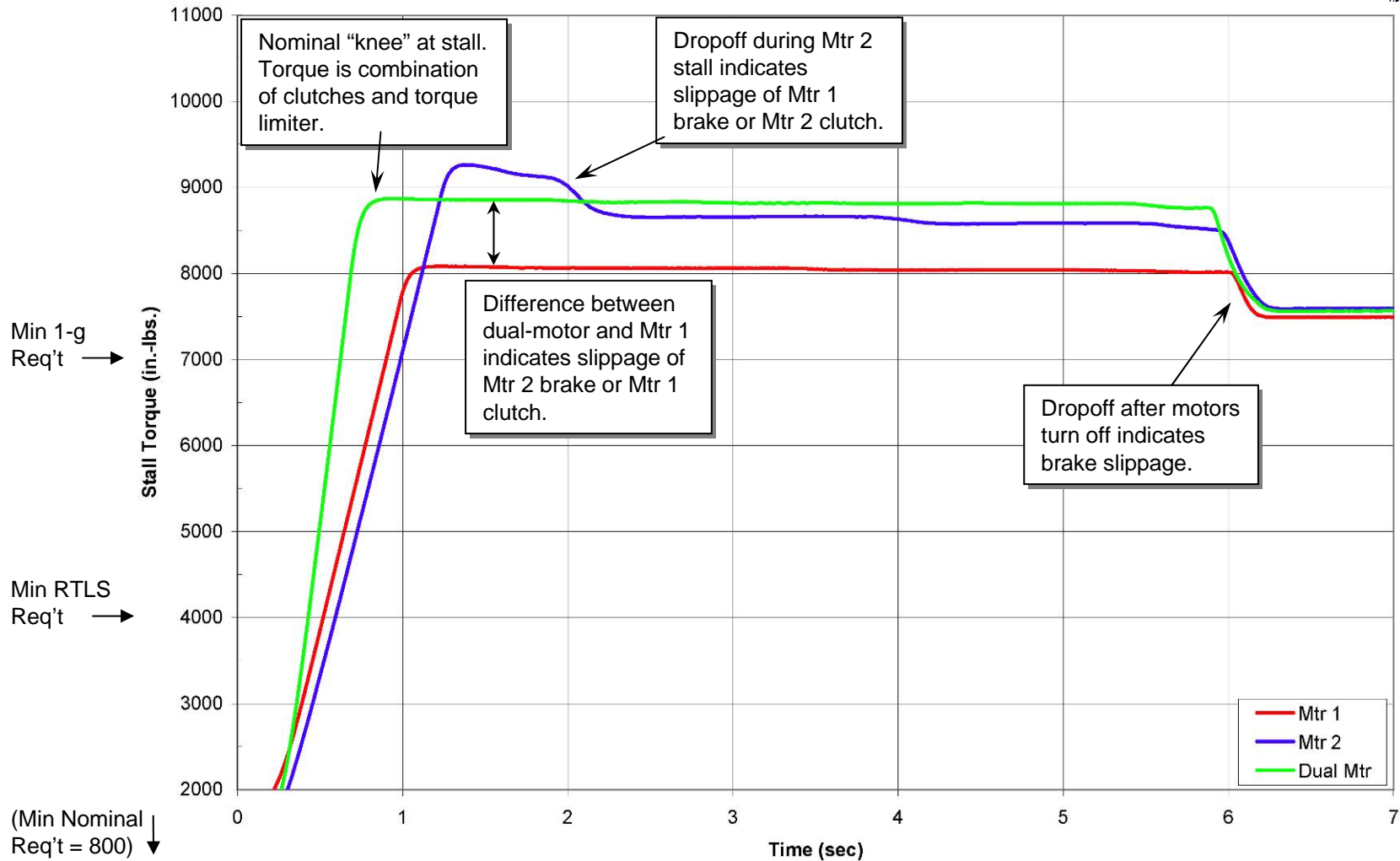


- Multiple test data points have been collected for each actuator in the fleet
- Several actuators exhibiting signs of both torque limiter and clutch/brake degradation
- Three actuators are of most concern for degradation of peak torque (initial trip point)
- One actuator is of concern for behavior during stall, but peak torque is acceptable

Sorted by Stall Torque:			Sorted by Total Degradation:			
S/N	Location	Min Peak Stall Torque	S/N	Location	Min Peak Stall Torque	Degradation from ATP
TU102	OV-104 RH	8,084	TU101	OV-105 RH	8,100	36.8%
TU101	OV-105 RH	8,100	TU115	OV-105 LH	8,879	23.5%
TU112	OV-103 RH	8,398	TU112	OV-103 RH	8,398	22.3%
TU113	OV-103 LH	8,551	TU113	OV-103 LH	8,551	21.2%
TU115	OV-105 LH	8,879	TU102	OV-104 RH	8,084	19.2%
TU116	OV-104 LH	9,914	TU116	OV-104 LH	9,914	14.5%
Sorted by Degradation Rate:						
S/N	Location	Min Peak Stall Torque	Degradation from ATP	Years since ATP	Degradation per Year	
TU112	OV-103 RH	8,398	22.3%	1.78	12.54%	
TU101	OV-105 RH	8,100	36.8%	3.43	10.74%	
TU113	OV-103 LH	8,551	21.2%	4.30	4.92%	
TU102	OV-104 RH	8,084	19.2%	7.84	2.44%	
TU115	OV-105 LH	8,879	23.5%	11.61	2.02%	
TU116	OV-104 LH	9,914	14.5%	12.15	1.20%	

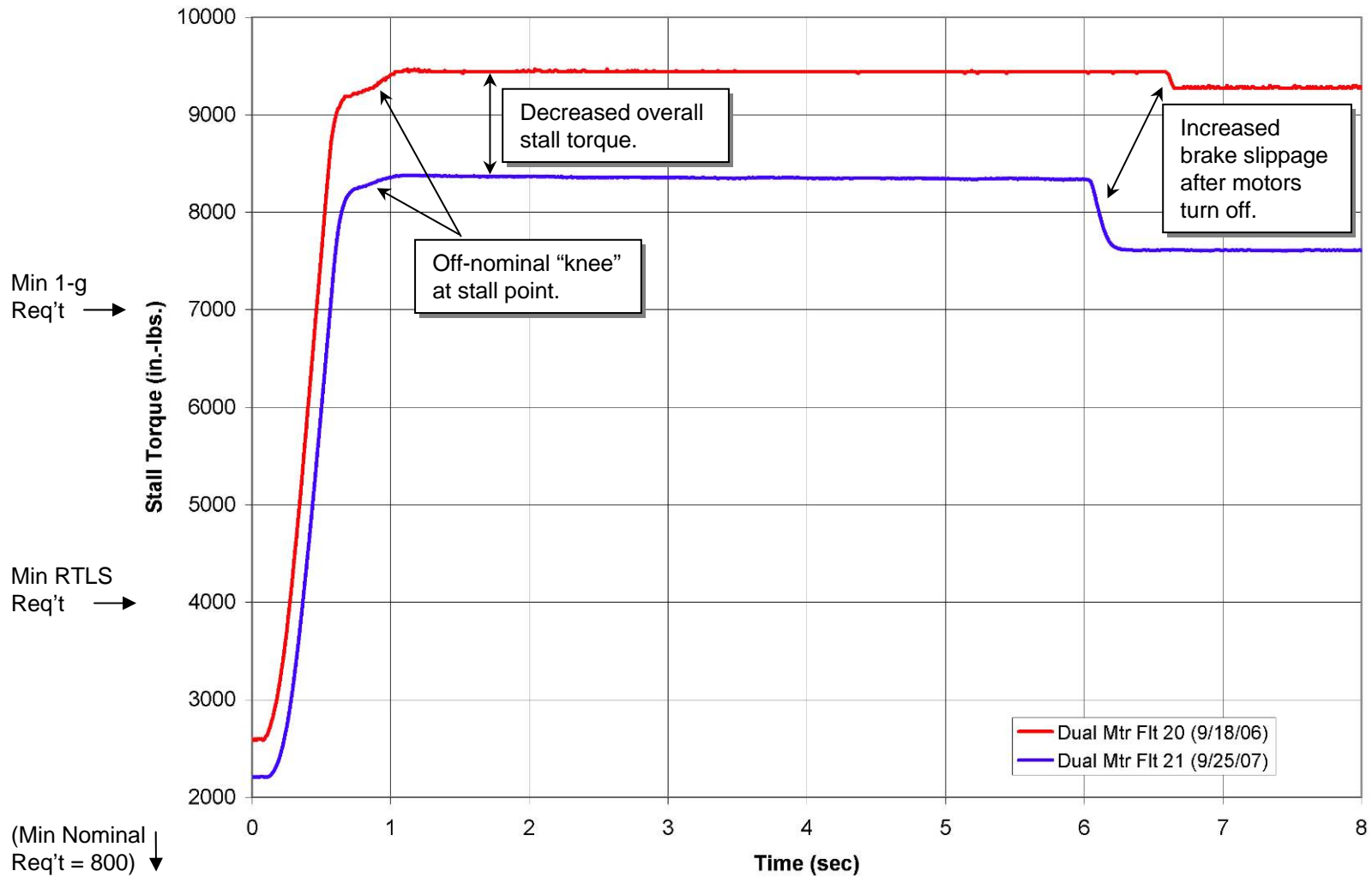
TU102 Push Test Results

(OV-104 RH, 4/09/08)



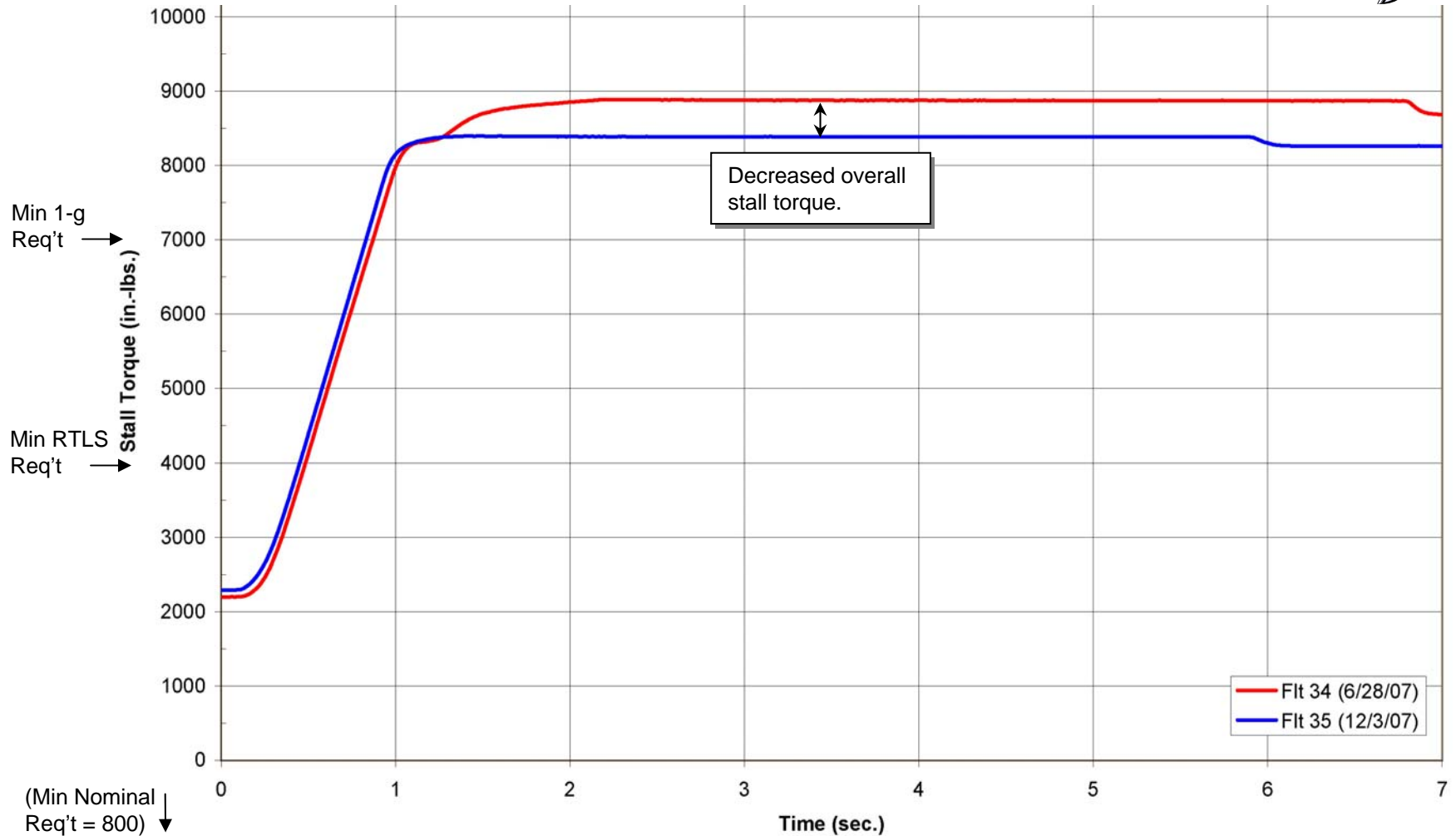
TU101 Push Test Results

(OV-105 RH, Dual Motor, Flts 20 & 21)



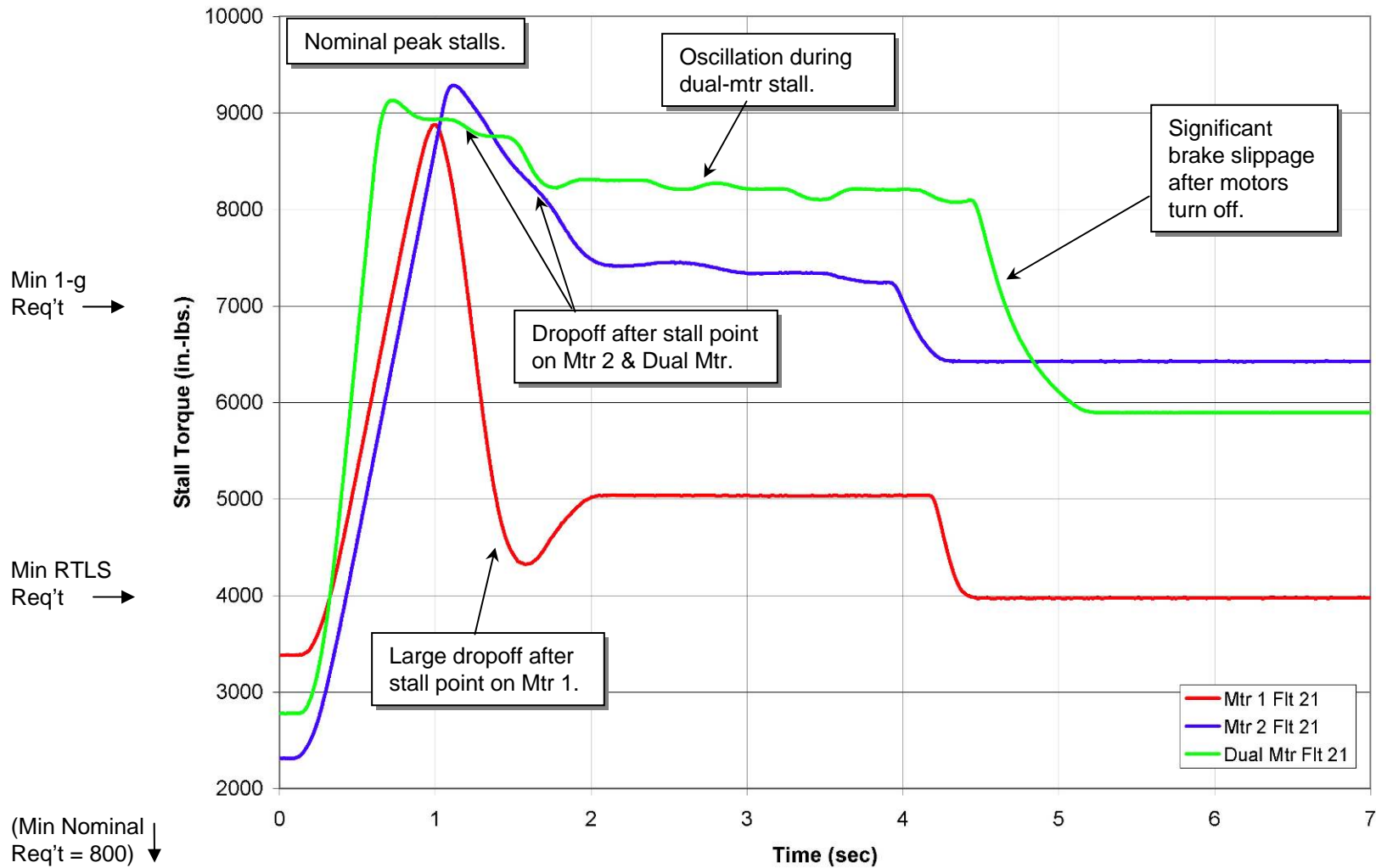
TU112 Push Test Results

(OV-103 RH, Motor 2, Flts 34 & 35)



TU115 Push Test Results

(OV-105 LH, 9/24/07)



Recommendation



- ET Door Drive Actuators should be cycled through the vendor/NSLD for repair of all three discrepant conditions
 - Trending results show continual degradation in stall torque
 - Rate varies between units and is not necessarily linear
 - Risk of failing functional test & requiring actuator R&R late in the flow
- TU101 R&R (OV-105 RH) should be scheduled during current flow
 - Most overall degradation since last ATP
 - Second-lowest overall stall torque
 - Second-highest degradation rate
 - Spare actuator (TU114) delivery estimated for late July or early August
- Once TU101 is repaired, candidates for next R&R should be:
 - TU102 (OV-104 RH)
 - TU112 (OV-103 RH)
 - TU115 (OV-105 LH)